Surface finish Thickness Determination on Printed Circuit Boards Sub-structures using Conventional XRF

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Metal thickness of surface finish plays a critical role in printed circuit boards reliability. One of the functions of a surface finish may be protecting against wear and corrosion while maintaining electrical functionality. For example, gold plated surfaces are widely used in finishing of electronic components because they offer low contact resistance and great protection against corrosion. Thickness measurement of surface finish is critical to validate that the product meets specifications and provides an important tool for assessing the quality of finished material, therefore informing decisions regarding acceptability of the product.

Thickness of metal coatings in industry is routinely determined by X-ray fluorescence (XRF) spectrometry. Conventional XRF instrumentation is supplied with a pinhole aperture (collimator) to restrict the incident beam at the sample surface with typical focal spot size varying in diameter from one millimeter to few millimeters. While this set up works well for determination of concentration and thickness on bulk material, the majority of sub-structures on a printed circuit board are often smaller than the focal spot size.

Data collected with a 1 mm collimator set up showed a significant loss of accuracy and sensitivity due to the elevated interfering signal from the background elements that are typically present in the solder mask of printed circuit boards. This resulted in a significant relative error in the measurement, estimated to be ≥30%.

To overcome these problems, a modified set up was employed. A custom made collimator with 0.25 mm aperture (sub-millimeter focal spot size) was implemented on a conventional XRF spectrometer and then tested. Data collected with this set up shows that thickness measurements on printed circuit boards sub-structures, as small as 0.7 mm, can be performed with an estimated error of 5%. This translates into a 5-10 fold error reduction compared to the measurement error with 1 mm collimator.

Accuracy of the system was confirmed by comparing measurements obtained with the 0.25 mm collimator to measurements obtained with micro-XRF and SEM tools. Measurement capability was assessed by statistical methods.